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We Claim:

1. A multi-hop wireless backhaul network comprising:

at least one NAN (network access node);

a plurality of BNs (base nodes);

a plurality of AGNs (aggregation nodes) each performing a switching function in relaying traffic between at least one of the base nodes and at least one of the network access nodes;

wherein a hierarchical topology of active wireless connections is established with the at least one network access node at the top of the topology, and the base nodes at the bottom of the topology.

2. A multi-hop wireless backhaul network according to claim 1 in combination with an access network comprising a plurality of access network nodes for which the multi-hop wireless backhaul network is providing backhaul functionality.

3. A multi-hop wireless backhaul network according to claim 2 wherein at least some of the access network nodes are co-located and connected to or integrated with respective nodes of the multi-hop wireless backhaul network.

4. A multi-hop wireless backhaul network according to claim 3, wherein the access network is a cellular wireless access network, and each access network node is a base station transceiver.

5. A multi-hop wireless backhaul network according to claim 1 adapted to establish a plurality of virtual circuits through said hierarchical topology, each virtual circuit

having an allocated bandwidth for delay-sensitive traffic, at least some of the virtual circuits being multi-hop virtual circuits.

6. A multi-hop wireless backhaul network according to claim 5 wherein each virtual circuit has a first circuit end-point in one of the at least one NAN, and has a circuit second end-point in either a BN of said plurality of BNs or an AGN of said plurality of AGNs.

7. A multi-hop wireless backhaul network according to claim 5 wherein each virtual circuit passes through one of said at least one NAN and has a first circuit end-point external to the BNs, AGNs, and at least one NAN, and has a second circuit end-point in either a BN of said plurality of BNs or an AGN of said plurality of AGNs.

8. A multi-hop wireless backhaul network according to claim 3 adapted to establish a plurality of virtual circuits through said hierarchical topology, each virtual circuit having an allocated bandwidth for delay-sensitive traffic, at least some of the virtual circuits being multi-hop virtual circuits, wherein each virtual circuit either has a first circuit end-point in one of the at least one NAN or passes through one of the at least one NAN to an external end-point, and has a second circuit end-point in either a BN of said plurality of BNs or an AGN of said plurality of AGNs, which second circuit end-point is combined with, co-located with or locally connected to an access network node of said access network and provides backhaul capacity for the access network node.

9. A multi-hop wireless backhaul network according to claim 1 further comprising a scheduler which performs a scheduling operation for nodes in the topology and transmits

at least one message containing resource assignment information.

10. A multi-hop wireless backhaul network according to claim 9 wherein the at least one message comprises identifiers of two nodes for an active connection, and at least one of: time slots of communications, an encoding format, a signaling format, a modulated format and transmission power.

11. A multi-hop wireless backhaul network according to claim 1 further comprising a scheduler on each node in the network, the schedulers collectively performing a scheduling operation to determine for each connection which two nodes are involved in the connection; and at least one of: time slots of communications, an encoding format, a signaling format, a modulated format and transmission power.

12. A multi-hop wireless backhaul network according to claim 8 wherein at least one BN or AGN is a second end-point for two or more virtual circuits.

13. A multi-hop wireless backhaul network according to claim 12 wherein at least two or more virtual circuits as established on respective distinct active wireless connections from the BN or AGN.

14. A multi-hop wireless backhaul network according to claim 5 wherein each virtual circuit is an end-to-end layer 2 circuit emulation, and wherein for each multi-hop virtual circuit.

15. A multi-hop wireless backhaul network according to claim 1, adapted to dynamically allocate bandwidth to each of the active connections.

16. A multi-hop wireless backhaul network according to claim 1 wherein each node maintains respective topology information identifying at least any active connections the node is participating in or any nodes with which the node has an active connection.

17. A multi-hop wireless backhaul network according to claim 1 wherein each AGN comprises a plurality of spatially switched antennas, and a transceiver operating in a TDM (time division multiplex) basis on the plurality of spatially switched antennas.

18. A multi-hop wireless backhaul network according to claim 17 wherein each BN comprises a plurality of spatially switched antennas, and a transceiver operating in a TDM (time division multiplex) basis on the plurality of spatially switched antennas.

19. A multi-hop wireless backhaul network according to claim 18 wherein each NAN comprises a plurality of antennas in a multi-sector antenna arrangement and a respective transceiver operating on each sector.

20. A multi-hop wireless backhaul network according to claim 19 wherein each active connection is established between a respective pair of said antennas on two nodes in the network, and wherein each connection is allocated respective active time slots during which the connection is active.

21. A multi-hop wireless backhaul network according to claim 1 further adapted to establish a plurality of alternate connections in addition to the active connections in said hierarchical topology.

22. A multi-hop wireless backhaul network according to claim 21 further adapted to perform automatic path healing upon failure of an active connection or a node in the network, using at least one of the plurality of alternate connections.

23. A multi-hop wireless backhaul network according to claim 22 wherein at least some of the BNs have respective alternate connections to either an AGN of said plurality of AGNs or to a NAN of said at least one NAN, and wherein at least some of the AGNs have respective alternate connections to either another AGN of said plurality of AGNs or to a NAN of said at least one NAN.

24. A multi-hop wireless backhaul network according to claim 22 adapted to allocate at least a signalling and/or ranging bandwidth for each alternate connection.

25. A multi-hop wireless backhaul network according to claim 22 adapted to detect when a failure has occurred affecting at least one of said active connections, and to maintain communication between the endpoints of the connection by using at least one alternate connection.

26. A multi-hop wireless backhaul network according to claim 25 adapted to perform automatic path healing upon failure by:

a node in the hierarchy directly below the failure establishing an active connection over an alternate connection from the node.

27. A multi-hop wireless backhaul network according to claim 26 wherein for a virtual circuit using the active connection or node which failed, performing automatic path healing comprises:

moving the virtual circuit to use at least one alternate connection, and scheduling bandwidth for the virtual circuit along at least each connection to form part of the virtual circuit after moving which was not previously part of the virtual circuit.

28. A multi-hop wireless backhaul network according to claim 27 further comprising a scheduler which performs a scheduling operation on the nodes in the network and transmits one or more resource assignment messages containing resource assignment information.

29. A multi-hop wireless backhaul network according to claim 28 wherein the resource assignment message comprises identifiers of two nodes for a connection, and at least one of: time slots of communications, an encoding format, a signaling format, a modulated format and transmission power.

30. A multi-hop wireless backhaul network according to claim 29 wherein the scheduler generates new resource assignment information as part of the automatic path healing.

31. A multi-hop wireless backhaul network according to claim 27 further comprising a scheduler on each node in the network, the schedulers collectively performing a scheduling operation to determine for each connection which two nodes are involved in the connection; and at least one of: time slots of communications, an encoding format, a signaling format, a modulated format and transmission power.

32. A multi-hop wireless backhaul network according to claim 31 wherein after a failure, the schedulers collectively perform a new scheduling operation.

33. A multi-hop wireless backhaul network according to claim 1 wherein each AGN and each BN is adapted to perform a ranging function to identify network nodes with which the AGN/BN can establish a connection.

34. A multi-hop wireless backhaul network according to claim 1 wherein upon at least one of power up, initialization and command, each AGN and each BN is adapted to perform a ranging function to identify another node with which the AGN/BN can establish a connection.

35. A multi-hop wireless backhaul network according to claim 20 wherein upon at least one of power up, initialization and command, each AGN and each BN is adapted to perform a ranging function to identify another node with which the AGN/BN can establish an active connection as part of said hierarchical topology, and in an attempt to identify at least one alternate node with which the AGN/BN can establish an alternate connection.

36. A multi-hop wireless backhaul network according to claim 20 wherein each alternate connection is established between a respective pair of antennas, and wherein each alternate connection is allocated respective signalling time slots during which the alternate connection is available for ranging or signalling.

37. A multi-hop wireless backhaul network according to claim 19 wherein each NAN dynamically allocates bandwidth to each AGN and/or BN with which the NAN has an active connection, and each AGN allocates bandwidth to each AGN and/or BN with which the AGN has an active connection.

38. A multi-hop wireless backhaul network according to claim 37 further adapted to establish a plurality of

alternate connections in addition to the active connections in said hierarchical topology.

39. A multi-hop wireless backhaul network according to claim 38 further adapted to perform automatic path healing upon failure of an active connection or a node in the network, using at least one of the plurality of alternate connections.

40. A multi-hop wireless backhaul network according to claim 39 adapted to dynamically allocate a bandwidth at least for signalling and/or ranging each alternate connection, and to allocate bandwidth for traffic for each alternate connection employed in path healing.

41. A multi-hop wireless backhaul network according to claim 1 in combination with an element management system adapted to provide management functions for the multi-hop wireless backhaul network.

42. A multi-hop wireless backhaul network according to claim 41 wherein the element management system is connected to the multi-hop wireless backhaul network via another transport network.

43. A multi-hop wireless backhaul network according to claim 41 wherein the element management system is connected to the multi-hop wireless backhaul network via a metro network.

44. A multi-hop wireless backhaul network of claim 4 in combination with an element management system adapted to perform management functions for the multi-hop wireless backhaul network connected to the multi-hop wireless backhaul network via a metro network, and further comprising a base station controller co-located with the element

management system, the base station controller providing a control operation for the base station transceivers.

45. A multi-hop wireless backhaul network of claim 7 in combination with an element management system adapted to perform management functions for the multi-hop wireless backhaul network connected to the multi-hop wireless backhaul network via a metro network, and further comprising a base station controller co-located with or locally connected to the element management system, the base station controller providing a control operation for the base station transceivers, wherein each the first end-point of each virtual circuit is in the element management system.

46. A multi-hop wireless backhaul network according to claim 45 wherein each virtual circuit is an Ethernet virtual circuit.

47. A NAN (network access node) for use in multi-hop wireless backhaul network the NAN comprising:

an interface to another transport network;

for each of at least two sectors, each transceiver and antenna establishing an active connection with another node in the network, a respective antenna and a respective transceiver;

the NAN being adapted to act as a wireless end-point for a plurality of virtual circuits through said network using said connections, each virtual circuit having an allocated bandwidth for delay-sensitive traffic, at least some of the virtual circuits being multi-hop virtual circuits.

48. A NAN according to claim 47 further adapted to act as a circuit emulation end-point for the plurality of virtual circuits.

49. A NAN according to claim 47 adapted to communicate on each connection using a respective schedule.

50. A NAN according to claim 49 wherein the schedule is in accordance with a received resource assignment comprising, for each connection, and at least one of: time slots of communications, an encoding format, a signaling format, a modulated format and transmission power.

51. A NAN according to claim 47 wherein each virtual circuit is an end-to-end layer 2 circuit emulation.

52. A NAN according to claim 47 further adapted to establish at least one alternate connection in addition to the active connections.

53. A NAN according to claim 52 adapted to allocate at least a signalling and/or ranging bandwidth for each alternate connection.

54. A NAN according to claim 47 wherein for each antenna, time slots are scheduled for and/or ranging functions.

55. A NAN according to claim 53 wherein each alternate connection is scheduled respective signalling time slots during which the connection is available for ranging and/or signalling.

56. A NAN according to claim 52 wherein each NAN dynamically allocates bandwidth to each active connection.

57. A NAN according to claim 52 further adapted to allocate a bandwidth for each alternate connection for ranging and/or signalling.

58. A NAN according to claim 47 adapted to maintain an Ethernet bridging table containing for each of a first plurality of destination addresses a respective egress wireless link identifier, and for each of a second plurality of destination addresses a respective egress wireline link identifier, and to perform switching of packets using the Ethernet bridging table.

59. An AGN (aggregation node) comprising:

a plurality of spatially switched antennas;

a transceiver adapted to operate on the plurality of spatially switched antennas in a TDM fashion to establish active connections with other network nodes in a hierarchical manner;

the AGN being adapted to perform a bi-directional relay function for backhaul traffic using at least one virtual circuit having an allocated bandwidth for delay sensitive traffic.

60. An AGN according to claim 59 in combination with an access network node of an access network.

61. An AGN according to claim 60 wherein at least one virtual circuit terminates in the AGN for carrying traffic of the access network node.

62. An AGN according to claim 59 adapted to perform layer 2 switching on traffic on the at least one virtual circuit.

63. An AGN according to claim 59 adapted to schedule transmission on the spatially switched antennas in accordance with a resource assignment specifying for each of at least two connections and at least one of: time slots of communications, an encoding format, a signaling format, a modulated format and transmission power.

64. An AGN according to claim 59 adapted to dynamically allocate bandwidth to each of the active connections.

65. An AGN according to claim 59 further adapted to establish at least one alternate connection in addition to the active connections.

66. An AGN according to claim 59 further adapted to perform automatic path healing upon failure of an active connection or a node in the network, using the at least one alternate connection.

67. An AGN according to claim 65 further adapted to allocate a bandwidth at least for signalling and/or ranging for each alternate connection.

68. An AGN according to claim 65 further comprising a scheduler performing a scheduling operation to determine for each active connection and each alternate connection and at least one of: time slots of communications, an encoding format, a signaling format, a modulated format and transmission power.

69. An AGN according to claim 59 adapted to schedule time slots for ranging and signalling functions.

70. An AGN according to claim 58 wherein upon at least one of power up, initialization and command, the AGN is adapted to perform a ranging function to identify another

node with which the AGN can establish an active connection, and in an attempt to identify at least one alternate node with which the AGN can establish an alternate connection.

71. An AGN according to claim 59 adapted to maintain an Ethernet bridging table containing for each of a first plurality of destination addresses a respective egress wireless link identifier, and for each of a second plurality of destination addresses a respective egress wireline link identifier, and to perform switching of packets using the Ethernet bridging table.

72. A BN (base node) for use at a bottom of a multi-hop wireless backhaul network, the BN comprising:

a plurality of spatially switched antennas;

a transceiver adapted to operate on the plurality of spatially switched antennas in a TDM fashion to establish an active connection with at least one other network node;

the BN being adapted to be an end-point for at least one virtual circuit through the backhaul network having an allocated bandwidth for delay sensitive traffic.

73. A BN according to claim 72 in combination with an access network node of an access network, wherein at least one virtual circuit terminates in the BN for carrying traffic of the access network node.

74. A BN according to claim 72 adapted to schedule transmission on the spatially switched antennas in accordance with a resource assignment specifying for each active connection and at least one of: time slots of communications, an ncoding format, a signaling format, a modulated format and transmission power.

75. A BN according to claim 72 further adapted to establish at least one alternate connection in addition to at least one active connection.

76. A BN according to claim 75 adapted to detect a failure on the at least one active connection, and to attempt to establish a traffic connection on the at least one alternate connection.

77. A BN according to claim 75 further comprising a scheduler performing a scheduling operation to determine for each active connection and for each alternate connection and at least one of: time slots of communications, an encoding format, a signaling format, a modulated format and transmission power.

78. A BN according to claim 77 adapted to schedule time slots for ranging and/or signalling functions to identify and/or maintain nodes with which connections can be established and is adapted to perform ranging and/or signalling during the time slots for ranging and signalling.

79. A BN according to claim 78 wherein upon at least one of power up, initialization and command, the BN is adapted to perform a ranging function to identify another node with which the BN establish an active connection, and in an attempt to identify at least one alternate node with which the BN can establish an alternate connection.

80. A BN according to claim 72 adapted to maintain an Ethernet bridging table containing for each of a first at least one address a respective egress wireless link identifier, and for each of a second at least one destination address a respective egress wireline link identifier, and to perform switching of packets using the Ethernet bridging table.